

**Case Study No. 15   UV-Cured Coatings**  
**Loewenstein, Inc.**  
**Pompano Beach, FL**

**Background**

Loewenstein, located in Pompano Beach, Florida, is a contract seating manufacturer using state-of-the-art manufacturing techniques. The company was founded in 1966 and became an important supplier to the hospitality industry. Loewenstein produces a wide range of chairs, stools, and benches, allowing customers to choose from more than 250 models in 16 standard wood finishes and over 3,000 custom finishes. They import fully machined and sanded European beech components and manufacture wood products in their plants in North Carolina and Tennessee. The Pompano Beach facility manufactures both wood and metal chairs, but does not finish any of the metal components. The facility has approximately 250 employees, and more than 200 of those are manufacturing employees.



Product sample

The Pompano Beach facility has reduced emissions in both their finishing and gluing operations. In mid-1984, Loewenstein began investigating the use of UV-curable coatings in an attempt to increase finish quality and speed the required curing time. By 1987, different technologies were being tested at an equipment supplier's laboratories. By 1988, a temporary UV curing oven was installed, allowing Loewenstein to continue testing without shutting down their main production line. The UV-curable system was in full production by November 1988. This case study provides an overview of Loewenstein's efforts to reduce VOC emissions by reformulating their stains and switching to UV-curable sealers and topcoats.

**Wood Finishing Operations**

Loewenstein uses automated electrostatic disk booths to finish chairs. The small quantities of benches that are manufactured are batch finished with electrostatic spray guns and UV-curable topcoat. Each disk booth has a ceiling-mounted, vertically reciprocating disk that is 9 inches in diameter. The stroke is adjustable and is varied according to the length of the parts being coated. The parts are conveyed around the disk about 18 inches away from the disk edge.

The configuration of each disk resembles a soup bowl with a "sink strainer" resting in the bottom of the bowl. The "bowl" is mounted upside down on the reciprocator. The edge of the disk is serrated to help with the paint atomization, and the angle of the disk

to the horizontal is about 15 degrees. The disk is connected to a shaft equipped with an air turbine. Variable air pressure ranging to 40 psi drives the turbine and disk.

Paint is metered into the perforated center, and centrifugal force hurls it out the holes to the inner surface of the disk and to the serrated edge where the paint is atomized. The disk is charged positively to between 75 and 100 kV, which gives an electrostatic charge to each atomized paint particle. The charged particles then are attracted to the closest ground, which should be the part to be coated. Makeup air is drawn into the top of the booth and exhausts through dry filters around the base. The downdraft air is necessarily gentle for minimal distortion of the path of the atomized paint particles from the disk to the parts to be painted.

A touchup booth is required after each disk booth because of the 250 varieties of chairs, stools and benches that are coated. Although the disk coverage is extremely efficient, the touchup booths serve to ensure total part coverage. Each manual touchup booth is a side-draft, dry-filter type. Makeup air enters the booth behind the spray operator's back and proceeds past the parts being conveyed laterally through the booth and to the particulate filters at the back of the booth. The operators in the stain touchup booth are equipped with non-electrostatic HVLP spray guns, while the touchup operators in the sealer and topcoat touchup booths are equipped with electrostatic spray equipment.



Disk booth

The first spray booth is used to apply the stains and opaque lacquer finishes. The booth consists of an Aerobel™ spray system and non-electrostatic HVLP manual spray guns for touchup. The sprayable, solvent-borne stains Loewenstein was using had high VOC contents. These stains were replaced with UV-compatible wood stains, aniline-based color stains, and opaque lacquer finishes. All stains and color coated parts are conveyed through a gas-fired oven to thoroughly dry the coating prior to sealer application.

The UV-curable sealer is applied in the first set of disk and touchup booths. The sealer is used to wet all surface areas and thereby lift sawdust particles and raise unsanded attached fibers. Flash time is allowed after the sealer is applied to give the coating adequate time to wet all surfaces and to allow evaporation of the solvents prior to the UV cure. The UV oven is equipped with six 48-inch UV lamps rated at 200 watts per inch. The actual required UV-cure time is about 15 seconds. Because eye-protective shielding devices had to be added around the UV lamps, the total conveyor time through the units is about 20 seconds. After the UV cure, the sealer coat is hand sanded to provide an ultra-smooth surface for the topcoat. The hand sanding tends to

be the limiting factor in the line's conveyor speed, which can be varied from 4 to 20 feet per minute.

The UV-curable topcoat disk and touchup booths are located within a clean room. The room has its own filtered air supply to minimize dust and lint collection to help ensure a dirt-free finish. Flash time again is allowed to ensure adequate dispersion of the coating before entering the UV oven. The cure time and curing equipment for the topcoat are identical to those of the sealer.

Spray booth filters are changed daily. Filters with trapped UV-curable coatings are run through the UV ovens to dry the coatings and facilitate waste disposal.

### **Gluings Operations**

The furniture industry traditionally has used contact adhesives for upholstery operations. Foam is glued to foam and to fabric during the manufacturing of upholstered office chairs. Traditionally, these adhesives have been solvent-borne products with 1,1,1-trichloroethane (also known as methyl chloroform), a HAP and ozone depleting chemical, as the primary solvent. In 1997, Loewenstein switched to a waterborne contact adhesive for their upholstery operations, thereby eliminating methyl chloroform emissions from gluing operations. The waterborne adhesive is 47 percent solids and dries quickly without drying equipment. The hand held applicator co-sprays adhesive and activator through a unique detachable twin nozzle spray tip. A single pressure control adjusts the output. The parts can be used within 5 to 15 seconds after application. A water/detergent solution is used for cleanup.

### **Conversion to UV-Cured Coatings**

As an initial means of reducing emissions, Loewenstein analyzed existing coating application methods, searching for ways to improve efficiency and economize on coatings use. This analysis included additional operator training to ensure sprayers were using the minimum amount of coating necessary. The resulting process changes enabled them to reduce VOC emissions by 50,000 pounds.

Before Loewenstein could switch to UV-cured coatings, they had to determine if UV-cured coatings could be formulated to match the coatings they currently were using (Loewenstein had not used nitrocellulose coatings since 1982). In initially researching the possibility of using UV-cured coatings, Loewenstein began UV-cured coating tests on their products. Numerous chairs were finished with UV-cured coatings at supplier test labs. Some UV-cured coatings appeared satisfactory, while others did not. After studying the test results, Loewenstein wanted to see how UV-cured coatings could be applied under production conditions. They arranged for a portable UV oven to be installed on the finishing line for a weekend of production testing. Four suppliers brought UV-cured coatings for the testing.

On the basis of the production testing, Loewenstein installed a temporary curing oven on their finishing line to allow switching back and forth from UV-cured coatings and UV curing to conventional coatings and gas-fired oven curing. This enabled Loewenstein

to focus on the development of UV-cured coatings to meet their requirements while continuing regular production.

Loewenstein's decision to permanently install UV equipment and a new finishing system marked the end of a two-year testing period. The new finishing line consists of an Aerobel™ spray system, two disk booths, three touchup booths, and two UV ovens. In addition, three repair booths are located off-line.

Several problems were encountered with the original UV-cured coating system that was used. The finish had a poor build, and the stains appeared fuzzy. The high-gloss black lacquer chairs had an "orange peel" finish. Some of the colors had poor adhesion and the white finishes appeared slightly yellow after the curing process. Finally, the UV-cured sealer did not have sufficient sanding properties. All of these problems were worked through with various coating reformulations and coating supplier changes.

There also were initial concerns about curing problems, since the product being coated is 3-dimensional. Early efforts caused the coating to burn. However, Loewenstein was able to work with the equipment and coating suppliers to perfect their 3-dimensional curing system. It is necessary to configure the system for each model to pass through the drying and curing process. Each part of the chair must be exposed to the UV lamps for the entire cure time.

Another potential problem was achieving good electrostatic attraction. Normally, wood receives a conductive prep coat before undergoing electrostatic painting. The prep coat provides a conductive coating to aid in attracting the electrostatically charged paint particles. Loewenstein does not apply a prep coat and is getting excellent electrostatic attraction. They believe that transporting the wood across the ocean in a ship adds salt water moisture to the wood surface. In addition, South Florida's high humidity provides a continuous surface moisture. The result is a conductive, moist wood surface that gives excellent electrostatic attraction.

Currently, the UV-cured coating system is performing well, and Loewenstein is happy with the quality of the finish. The UV-cured coating system brought many other advantages, the most noticeable being a sharp reduction in VOC emissions. Other advantages of the UV-curable coating system include:

1. Improved coating quality; excellent film properties and appearance.
2. Improved atomization and increased transfer efficiency at production speeds due to low coating viscosity. The transfer efficiency of the electrostatic disks is between 80 and 90 percent, and that of the electrostatic manual guns is 70 to 80 percent.
3. Higher solids content, resulting in a coating material savings per piece.
4. A harder sealer film that allows extensive sanding without wearing through the coating.

5. A reduction in necessary floor space of 40 percent, allowing expansion without purchasing an additional building.
6. A reduction in cure time from 45 minutes (in conventional gas-fired ovens) to 20 seconds (in the UV ovens) that resulted in a dramatic increase in production capacity and shortened turn-around times.

### **Costs**

Loewenstein spent about \$2 million and nearly 2 years developing their new finishing system. As a result, they have experienced cost savings in several areas. The number of rejects decreased as a result of the changes in application methods. Although the UV-curable coatings cost more per gallon than traditional solvent-borne coatings, the solids content of the UV-curable coatings is much higher. A sealer coat application and a topcoat application were eliminated from all finishes resulting in a material savings. Two sealer coats and two topcoats formerly had to be applied with the original finishes. The relatively high solids content of the sealer and topcoat allows total film thickness (3 to 4 mils) to be reached with fewer applications than before. Energy costs have been reduced due to the elimination of several spray booths and labor costs have been reduced due to the level of automation of the new coating line and the elimination of the wiping stains. Because of the extremely short curing time of the UV-curable sealer and topcoat, shipping time was cut dramatically and Loewenstein was able to increase production.

### **Emissions**

The net effect of the emissions reduction program at Loewenstein has been significant. Emissions of methyl chloroform have been eliminated due to the implementation of the waterborne contact adhesive. Loewenstein also has eliminated all phenolic resins and chlorofluorocarbons from the foam used in their upholstered products.

According to data provided by the facility, the solvent-borne wood coatings used previously were 16 percent solids, with a VOC content of 5.9 pounds per gallon. The current UV-curable sealer and topcoat have around 40 percent solids and less than 5 pounds of VOCs per gallon. The UV-compatible stains have VOC contents that range from 1 to 7 pounds of VOCs per gallon. Total VOC emissions at the facility have decreased from 145 tons per year in 1987 to 37 tons per year in 1997, with a large production increase during this same time period.

Loewenstein is subject to the Wood Furniture NESHAP. The average HAP content of all the wood coatings used currently is between 0.5 and 0.6 pound of HAP per pound of solids. The HAP content of the UV-curable sealer is 0.2 pound of HAP per pound of solids, and several of the stains contain no HAPs. Loewenstein currently is working with their primary coating supplier to reformulate their conventional coatings with non-HAP components and further reduce emissions.